PART I - ADMINISTRATIVE

Section 1. General administrative information

Title of project	
Evaluation of Juvenile Fall Chinook Stranding on The Hanford Reach	
BPA project number	**9701400**
Contract renewal date (mm/yyyy)	**02/1999**
Multiple actions? (indicate Yes or No)	**Yes**
Business name of agency, institution or organization requesting funding	
Washington Department of Fish and Wildlife	
Business acronym (if appropriate)	**WDFW**
Proposal contact person or principal investigator:	
Name	**Paul Wagner**
Mailing address	**500 N Morain, Suite 1300**
City, ST Zip	**Kennewick WA 99336**
Phone	**(509)734-7101**
Fax	**(509)734-7102**
Email address	**pwagner@televar.com**
NPPC Program Measure Number(s) which this project addresses	
Page 5-20, 5.1D.4	
FWS/NMFS Biological Opinion Number(s) which this project addresses	
National Marine Fisheries Service Endangered Species Act - Section 7 Biological Opinion on the Reinitiation of Consultation on 1994-1998 Operation of The Federal Columbia River Power System and Juvenile Transportation Program, Page 162 #11.	
Other planning document references	
Short description	
Evaluate effect of diel water fluctuations resulting from power peaking activities at Priest Rapids Dam on: 1) rearing juvenile fall chinook, 2) resident fish, and 3) the benthic community inhabiting the Hanford Reach of the Columbia River. Assess direct and delayed mortality and increased susceptibility to predation of juvenile chinook resulting from exposure to warm water in entrapment zones created by discharge fluctuations. Develop a GIS based juvenile chinook susceptibility model integrating detailed river bathymetry (COE-SHOALS), juvenile fall chinook habitat utilization mapping (USGS/BRD), and two flow models (USFWS-IFIM, PNNL-Unsteady Flow Model).	
Target species	
Wild Juvenile Upriver Bright Fall Chinook	

Section 2. Sorting and evaluation

Subbasin
Lower Mid-Columbia Mainstem

Evaluation Process Sort

CBFWA caucus		**CBFWA eval. process**		**ISRP project type**	
X one or more caucus		If your project fits either of these processes, X one or both		X one or more categories	
X	Anadromous fish	X	Multi-year (milestone-based evaluation)		Watershed councils/model watersheds
	Resident Fish		Watershed project eval.		Information dissemination
	Wildlife				Operation & maintenance
					New construction
				X	Research & monitoring
					Implementation & mgmt
					Wildlife habitat acquisitions

Section 3. Relationships to other Bonneville projects

Umbrella / sub-proposal relationships. List umbrella project first.

Project #	**Project title/description**

Other dependent or critically-related projects

Project #	**Project title/description**	**Nature of relationship**
9102900	Life History of Fall Chinook in Columbia River Basin	Shared personnel, equipment, and cost sharing for modeling work.
8605000	White Sturgeon Restoration and Enhancement in Columbia and Snake Rivers Upstream from Bonneville Dam.	Sharing of Hanford Reach Flow Modeling Information
DDS-W-98-4	Predicting The Effects of Reservoir Drawdown on Juvenile Salmonids and Their Predators (COE funded)	Shared personnel, equipment, resident fish data.

Section 4. Objectives, tasks and schedules

Past accomplishments

Year	Accomplishment	Met biological objectives?
1997	Pilot assessment of juvenile chinook stranding in Hanford Reach	Yes, pilot work completed.
1998	First of two year field assessment of juvenile fall chinook stranding in Hanford Reach	Ongoing determination of flow fluctuation effect on juvenile fall chinook
1998	First of two year field assessment of resident fish stranding in Hanford Reach	Ongoing determination of flow fluctuation effect on resident fish
1998	First of two year field assessment of flow fluctuation effect on benthic macroinvertebrate community	Yes, colonization variability, site and artificial substrate selection completed
1998	First of two year laboratory assessment of temperature tolerance of juvenile fall chinook	Yes, predator susceptibility relative to thermal stress and thermal shock evaluated
1998	Susceptibility Modeling Work	Unsteady Flow Model for Hanford Reach completed. SHOALS (detailed bathymetry) survey work completed for 1/3 of Hanford Reach. Microhabitat surveying work for specific entrapments completed.

Objectives and tasks

Obj 1,2,3	Objective	Task a,b,c	Task
1	Completion of GIS based susceptibility model	a	Complete bathymetry surveying work for Hanford Reach
		b	Final integration of all model components
2	Final Data Analysis	a	Final data analysis - juvenile chinook stranding
		b	Final data analysis - resident fish stranding
		c	Final data analysis - Macroinvertebrates stranding
		d	Final data analysis- juvenile chinook thermal tolerance
3	Final Reporting	a	Final Report Completion

Objective schedules and costs

Obj #	Start date mm/yyyy	End date mm/yyyy	Measureable biological objective(s)	Milestone	FY2000 Cost %
1	10/1999	09/2000	Susceptibility Model	X	50
2	10/1999	09/2000	Final analysis of flow fluctuation effect on river ecology of Hanford Reach	X	30
3	10/1999	09/2000	Final Report	X	20
				Total	100

Schedule constraints
Research project scheduled to be completed in FY2000. Schedule change could result from Fish/Tribal agency consensus to conduct additional field studies.
Completion date
Research and final report to be completed by in FY2000. Some level of monitoring effort likely to continue indefinitely.

Section 5. Budget

FY99 project budget (BPA obligated):	$385,000

FY2000 budget by line item

Item	Note	% of total	FY2000 ($)
Personnel	Wages	30.9	$67,000
Fringe benefits	Employee Benefits	10.1	$22,000
Supplies, materials, non-expendable property		0.9	$2,000
Operations & maintenance			
Capital acquisitions or improvements (e.g. land, buildings, major equip.)			
NEPA costs			
Construction-related support			
PIT tags	# of tags:		
Travel		1.8	$4,000
Indirect costs	Administrative Overhead	8.8	$19,000
Subcontractor	US Army Corps of Engineers SHOALS Survey	23.0	$50,000

	USGS/BRD	10.6	$23,000
	Pacific Northwest National Laboratories	13.8	$30,000
Other			
		TOTAL BPA REQUESTED BUDGET	$217,000

Cost sharing

Organization	Item or service provided	% total project cost (incl. BPA)	Amount ($)
Grant County PUD	Overall Project Cost Share	15.8	50,000
USGS/BRD	50% Cost Share for SHOALS Survey	15.8	50,000
		Total project cost (including BPA portion)	317,000

Outyear costs

	FY2001	FY02	FY03	FY04
Total budget	20,000	20,000	20,000	20,000

Section 6. References

Watershed?	Reference
	Anglin, D.R. 1995. Report E in K. Beiningen, editor. Status and habitat requirements of white sturgeon populations in the Columbia and Snake rivers upstream from McNary Dam. Annual Report (April 1993- March 1994) to the Bonneville Power Administration (Project 86-50), Portland, Oregon. Anglin, D.R. 1996. Report E in K. Beiningen, editor. Status and habitat requirements of white sturgeon populations in the Columbia and Snake rivers upstream from McNary Dam. Annual Report 1994 to the Bonneville Power Administration (Project 86-50), Portland, Oregon. Anglin, D.R. In progress. Report E in K. Beiningen, editor. Status and habitat requirements of white sturgeon populations in the Columbia and Snake rivers upstream from McNary Dam. Annual Report 1995 to the Bonneville Power Administration (Project 86-50), Portland, Oregon. Anglin, D.R. In progress. Report E in K. Beiningen, editor. Status and habitat requirements of white sturgeon populations in the Columbia and Snake rivers upstream from McNary Dam. Annual Report 1996 to the Bonneville Power Administration (Project 86-50), Portland, Oregon. Bauersfeld, Kevin. 1978. Stranding of Juvenile Salmon by Flow Reductions at Mayfield Dam on The Cowlitz River, 1976. Technical Report No. 36. Washington Department of

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Coutant C.C. and J. M. Dean. 1972. Relationships Between Equilibrium Loss and Death as Responses of Juvenile Chinook Salmon and Rainbow Trout to Acute Thermal Shock. BNWL-1520 UC-48. Pacific Northwest Laboratories. Richland, Washington.

Dean, J. M. and C. C. Coutant. 1968. Lethal Temperature Relations of Juvenile Columbia River Chinook Salmon. In Biological Effects of Thermal Discharges: Annual Progress Report for 1967. BNWL-714, Pacific Northwest Laboratory. Richland, Washington.

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PART II - NARRATIVE

Section 7. Abstract

This work is consistent with objectives identified in both the 1994 CBFWP and the BIOP and will

serve to minimize fish losses resulting from hydroelectric generation activities. The objectives of this study are to determine the effect of diel flow fluctuations resulting from power peaking activities at Priest Rapids Dam on: 1) rearing juvenile chinook (primary), 2) resident fish, 3) benthic macroinvertebrates, and 4) to develop a GIS based susceptibility model. Field work began in 1997 (pilot year) and is scheduled to conclude in 1999. River flows were exceptionally high in 1997 and minimal entrapment was observed as much of the population of juvenile chinook which would normally rear in the Hanford Reach were displaced downstream. Ambient river flow was lower in 1998 and approximately 31,500 chinook were sampled from entrapments of which approximately 1/3 were classified as direct mortalities. Direct mortality resulted most often from: 1) entrapment drainage and "stranding", and 2) warming of entrapped water. Approximately 95% of the entrapped chinook were sampled from entrapments created by river elevation reductions of 3 vertical feet or less and 45% by reductions of 1 foot or less. This is a cooperative research project. Chinook delayed mortality/reduced performance ability resulting from exposure to warm water as well as the effects of thermal shock during reflooding events is being assessed in the laboratory by the USGS/BRD. The PNNL is leading the modeling effort in cooperation with the USGS/BRD and USFWS. Resident fish assessment is in cooperation with the USGS/BRD as part of a COE funded assessment of drawdown. Benthic work is being conducted by the University of Idaho Department of Fish and Wildlife and Streamside Program Consultants (C.E. Cushing). The results of this evaluation are expected to yield 1) an assessment of the impact of diel water fluctuations on: A) juvenile chinook, B) resident fish, and C) the benthic community of the Hanford Reach as well as recommendations for corrective action (operational constraints). A comprehensive GIS based susceptibility model will also be created to determine the duration in which operational constraints will be imposed. This will require annual monitoring. FY2000 work will consist: 1) additional bathymetric survey work (most likely through subcontract with the COE for SHOALS surveying) as needed to complete the modeling effort, 2) final data analysis, and 3) final reporting.

Section 8. Project description

a. Technical and/or scientific background

The Hanford Reach is subject to flow manipulation from Priest Rapids Dam, where hourly flows fluctuate rapidly due to changes in hydroelectric generation (peaking), irrigation, water storage, and flood control. These rapid fluctuations in river flow are a known cause for stranding newly emerged fry on gently sloped banks and gravel bars, and the entrapment of all life stages in potholes formed by the receding water. Currently, a minimum flow restriction is maintained for the Hanford Reach during fall spawning to protect pre-emergent salmonids but flows fluctuate above the restricted level and are not managed after emergence. A minimum discharge criterion of 36,000 cfs is specified in the Federal Energy Regulatory Commission (FERC) license for the Priest Rapids project (Federal Power Commission, 1959). However, a ramping rate restriction is not specified and tailwater reductions in excess of 13 vertical feet within a 24 hour period and 7 vertical feet/hour have been documented under normal project operations.

Previous stranding studies on the Cowlitz (Tipping et al 1978, Tipping et al 1979, and Bauersfeld 1978), Skagit (Beck Associates 1989, Phinney 1974a, Thompson 1970, and Woodin 1984), and Lewis (Phinney 1974b) rivers have documented the existence of fry stranding during controlled flow drawdown experiments. Studies such as these have resulted in the establishment

of ramping rate guidelines to minimize fish stranding in systems where river flows are controlled by hydroelectric projects. In addition, Witty and Thompson (1974) noted that fry stranding does occur in Hell's Canyon of the Snake River, Idaho, even when flow and river level fluctuations are maintained within their Federal Energy Regulatory Commission (FERC) license guidelines.

The Hanford Reach supports the largest of the only two remaining wild fall chinook populations in the Columbia River system. This population of fish is a primary contributor to ocean and freshwater sport and commercial fisheries and in river tribal fisheries. It is also a primary component of an international Pacific Salmon Treaty between the United States and Canada. The possibility of a salmonid fry stranding problem has been well documented for the Hanford Reach. Two studies to document fry stranding on the Hanford Reach (Becker et al 1981, and Page 1976) have shown that stranding of juvenile salmonids and other fishes do occur, but these studies were of short duration and only qualitative in nature. Results of past studies have not been enough to warrant a change in operating procedures at Priest Rapids Dam. Observations in 1988 and as recently as 1995 of chinook fry stranding and entrapment have been made by Washington Department of Fish and Wildlife (WDFW) personnel under normal operating conditions. The implementation and results of a quantitative study are needed to fully assess the degree of stranding and the impact on the fish community and river ecology of the Hanford Reach as well as to develop recommendations for mitigation of losses in place.

In summary, this research project addresses a clearly identifiable problem and is consistent with the objectives of both the 1994 CRBFWP and the NMFS BIOP. The work draws together technical experts with extensive scientific backgrounds to assist in or conduct various aspects of this study and complements the work of other ongoing studies through collaboration and the sharing of staff, equipment, and data.

b. Rationale and significance to Regional Programs

The Bonneville Power Administration is directed through the National Marine Fisheries Service Endangered Species Act - Section 7 Biological Opinion on the Reinitiation of Consultation on 1994-1998 Operation of The Federal Columbia River Power System and Juvenile Transportation Program as such: " Beginning in 1995, BPA will evaluate the affect of power peaking operations on juvenile and adult salmon passage and on the river ecology downstream of Bonneville Dam and on the Hanford Reach, downstream of Priest Rapids Dam. Contingent on the results of these evaluations, BPA will develop a plan to decrease power peaking operations from mid-March through mid-December on the lower Snake and Columbia Rivers (Page 162, #11)". In addition, the 1994 Columbia River Basin Fish and Wildlife Program states as a program objective " Beginning in 1995, evaluate alternative ramping rates for flow fluctuations at mainstem Snake and Columbia River dams to constrain reductions and increases in total flow per 24-hour period at these projects." (Page 5-20, 5.1D.4). The proposed work is consistent with both of these objectives through the assessment of effects of diel water fluctuations on rearing wild juvenile upriver bright fall chinook and on the river ecology (resident fish, benthic macroinvertebrates) of the Hanford Reach. A technical work group consisting of affected fish agency, tribal, and hydrosystem managers has been assembled to review and guide the study as well as develop interim water management strategies for evaluation in 1999.

The end product of this ongoing research study will likely be a water management plan for Priest Rapids dam and the six other dams located upstream to mitigate for fish losses in place. A

comprehesive GIS based juvenile fall chinook susceptibility model for the Hanford Reach as well as an integrated hydrosystems model for the seven hydroprojects located upstream of the Hanford Reach are two unique products which will result from this work. Detailed bathymetry of the Hanford Reach will be obtained through the susceptibility modeling effort and this information can be used for DOE Hanford Nuclear Reservation contaminant studies. In addition, the assessment of juvenile chinook mortality related to thermal stress and thermal shock may have broad applicability to EPA water temperature standards as well as to summer migrant passage problems at bypass systems of mainstem hydroprojects.

c. Relationships to other projects

This is a cooperative study which integrates the past and present work of several agencies including the sharing of personnel, equipment, technical expertise, and technical data. USGS/BRD conducted an evaluation of juvenile fall chinook habitat utilization in the Hanford Reach from 1991 through the present (Rondorf et. al. 1991-1997, Key et. al. 1994). This work is ongoing and includes detailed habitat mapping surveys. This survey information is a necessary component of the susceptibility model which is being developed for the Hanford Stranding Evaluation. The BRD lead field supervisor (Loreley Key) has been hired on intermittent status by both BRD and WDFW to continue the survey work for both studies. This minimizes personnel costs for each study while still ensuring competent and compatable data collection. In addition, other staff, surveying/field equipment, surveying data, and biological take (ESA section 10 permit) are shared between the two agencies.

Based upon field observations made during the first two field seasons, exposure to warm water in entrapment zones was a primary cause of direct juvenile chinook mortality related to diel water fluctuations. Delayed mortality and reduced performance ability/predator susceptibility are other likely effects of thermal stress (Coutant 1969a, Coutant 1969b, Coutant 1970, Coutant and Dean 1972, Dean and Coutant 1968, Jaske et. al. 1970, Templeton and Coutant 1971) but these cannot be measured in the field. Therefore, the BRD Columbia River Research Laboratory has been subcontracted to conduct laboratory tests to determine juvenile fall chinook behavioral and physiological responses to exposure to elevated water temperatures and to thermal shock. BRD was subcontracted for this work due to their technical expertise in the evaluation of acute stressors on physiological and behavioral effects on juvenile salmonids (Mesa 1994).

BRD has also received funding through a COE contract to evaluate predator habitat utilization in the Hanford Reach. This work began in 1998 and in several aspects overlaps with resident fish work conducted for the Hanford Stranding Evaluation. Therefore, field staff, equipment, field data, and laboratory identification of larval resident fish will be shared between the BRD study and the Hanford Stranding Evaluation.

An Unsteady Flow Model was developed by PNNL under COE contract for use in modeling dissolved gas transport in the Snake River. PNNL was also subcontracted under the Hanford Stranding Evaluation to develop an Unsteady Flow Model for the Hanford Reach which is a necessary component of the final susceptibility model. This model describes the stage/discharge relationship between the Priest Rapids Project and all points located downstream on the Hanford Reach and is a direct derivation of the Snake River model. The same technical lead (Marshall Richmond) was responsible for the development of both models. In addition, PNNL is currently under BPA contract to develop a Spawning Habitat Model For Snake River Fall Chinook (Geist et. al. 1997 - BPA Project Number 9406900). This work includes GIS mapping and modeling of the Hanford Reach for fall chinook redd distribution relative to the

hyporheic flow. The GIS technical lead (John Nugent) is a shared employee between PNNL and WDFW and conducts Hanford Reach GIS work for both studies. Other staff, equipment, and technical information are also shared between the two organizations. In addition, as part of the modeling effort, the COE was subcontracted to conduct a Scanning Hydrographic Operational Airborne Lidar Survey (SHOALS) in 1998 to obtain detailed bathymetric information for a portion of the Hanford Reach. The cost of this survey was split between WDFW and USGS/BRD as the information is needed for two BPA funded projects. This work and cost sharing will continue in year 2000.

The USFWS has been subcontracted by BPA/ODFW (Anglin 1995, Anglin 1996, BPA Project Number 8605000) to develop an Instream Flow Incremental Methodology model of the Hanford Reach for sturgeon habitat modeling. This information will also be made available to WDFW for incorporation into the juvenile fall chinook susceptibility model.

Evaluation of the effect of diel water fluctuations on the benthic macroinvertebrate community inhabiting the Hanford Reach will be conducted via subcontract by the University of Idaho Department of Fish and Wildlife which has extensive work history conducting similar work on the Snake River under other federal contracts (Bennett et. al. 1990, 1991, 1993, 1997). C.E. Cushing (formerly of PNNL) has been subcontracted to assist in the development, implementation, and analysis of data because of his expertise pertaining to limnological work on the Hanford Reach.

d. Project history (for ongoing projects)

The pilot year for this project was 1997 (previous BPA project # 5503800). This year was essentially a set up year during which staff were recruited, hired and trained, equipment was purchased, specific field sampling methods were established, primary juvenile fall chinook production and rearing areas were identified, the Hanford Reach was stratified into gross habitat categories to aid in the establishment of specific sampling site locations, and field data were collected to better define the susceptibility period for fall chinook as well as specific habitat characteristics as related to sampling logistics. Limited juvenile chinook stranding/entrapment was observed during this exceptionally high flow year. Thermal stress induced juvenile fall chinook mortality in entrapment areas was identified as a problem requiring increased focus. Detailed micro-habitat map surveys were conducted in conjunction with USGS/BRD to define specific characteristics entrapment areas. An Unsteady Flow Model was developed by PNNL for this project. Eleven years of Priest Rapids Dam hourly flow data was analyzed and a controlled river elevation reduction test schedule and protocol were developed for the second year of this evaluation (1998). The feasibility of conducting the benthic evaluation was assessed and a work plan and budget were written. An interim report was completed.

Last year (1998) was the second year of this three year evaluation. The controlled river elevation reduction test schedule developed in 1997 was not implemented in 1998 due to a combination of insufficient ambient river flows and early emergence timing of wild fall chinook. Field work was conducted under normal Priest Rapids Project operations. Field data pertaining to entrapment physical characteristics/locations/dimensions, specific entrapment elevations, water chemistry and temperature, fish size/abundance/densities, were collected throughout the fall chinook emergence and rearing period and throughout the summer months for resident fish assessment. Resident fish work was conducted in coordination with USGS/BRD resident fish research also occuring in the Hanford Reach.

In 1998, river fluctuations occurred most frequently in gravel bar type habitat as opposed

to terrestrial vegetation habitat as was the case during the high flow year of 1997. Observations of stranded/entrapped chinook on gravel bars were common in 1998. Approximately 31,500 stranded/entrapped chinook were sampled in 1998 of which one third were classified as direct mortalities resulting from either: 1) entrapment drainage and "stranding", or 2) thermal stress due to entrapment warming. The number of fish sampled represented only a small portion of the chinook population entrapped and placed at risk in 1998 and therefore letters were issued by the both the Independent Scientific Review Panel and WDFW (on behalf of the Fish Passage Advisory Committee) recommending/requesting interim mitigation actions to minimize the problem. The recommended actions included flat loading the Priest Rapids Project during the remainder of the fall chinook rearing period in 1998 and throughout the 1999 rearing period. Analysis of specific entrapment elevation data collected in 1998 indicated that roughly 1/2 of all chinook sampled were entrapped by water reductions of one vertical foot or less (20 kcfs) and over 90% were entrapped by water reductions of three vertical feet (50 kcfs) or less. Chinook densities in entrapments were greatest in April of 1998. Chinook entrapment densities declined tenfold during May of 1998 when discharge from the Priest Rapids Project increased above 150 kcfs (tailwater elevation 411 ft). The 150 kcfs threshold represents the start of the terrestrial vegetation line in the Hanford Reach and it was postulated that terrestrial vegation may reduce the likelihood of stranding by providing a protective barrier to rearing fall chinook.

In response to the obvious nature of the problem and the extreme corrective measures recommended, a technical work group consisting of representatives of all affected fish and tribal agencies and hydropower managers was assembled to: 1) review the results to date, 2) identify and coordinate interim mitigation options for 1999, and 3) assist in the establishment of the 1999 study design. Both 2) and 3) are ongoing and will be completed prior to March of 1999.

Micro-habitat surveying was continued in 1998 in conjunction with the ongoing modeling effort. A SHOALS survey of 17 miles (1/3) of the Hanford Reach was completed by the U.S. Army Corps of Engineers for this project. The cost of this work was split with another BPA funded USGS/BRD fall chinook research project (Project # 9102900) also occurring in the Hanford Reach. PNNL continued work on the overall susceptibility model including addition of water temperature and total dissolved gas fields to the Unstready Flow Model, calibration and validation of the Unsteady Flow Model, establishment of an internet site to allow limited access to the Unsteady Flow Model by other agencies, and linkage of Unsteady Flow Model to GIS.

Benthic field work was initiated in 1998 to determine sampling site, test duration, and artificial substrate selection for river fluctuation tests planned for 1999. The field work was completed in 1998 and the associated laboratory work is in progress.

Thermal profile data were collected from specific entrapments in 1998 and used to establish the thermal regime under which laboratory temperature tolerance tests were conducted by USGS/BRD. Thermally stressed fall chinook predator vulnerability tests were conducted in 1998 at the Columbia River Research Laboratory. Laboratory testing of juvenile chinook temperature tolerance will continue in 1999 by USGS/BRD and will include direct mortality and physiological effects of sublethal heat stress.

This project is currently entering the third year (FY99) of a three year field assessment. BPA funding allocated to date is: FY97 ($174,521), FY98 ($350,000), FY99($385,000).

e. Proposal objectives

This proposal is to conduct the final phase of the Evaluation of Juvenile Fall Chinook Stranding on The Hanford Reach during FY2000. The specific objectives for FY2000 are:

1) Completion of a GIS based fall chinook stranding susceptibility model of the entire Hanford Reach. PNNL will act as the lead in this effort. The work will include integration of all model components including micro-habitat surveys by WDFW and USGS/BRD, Unsteady Flow Model (PNNL), IFIM for Hanford Reach (USFWS), and SHOALS (COE) bathymetric data. Additional SHOALS work may be necessary in FY2000 to complete bathymetry for the entire Hanford Reach and is included as a task under this objective. The susceptibility model will be created specifically for this project and used for future monitoring efforts relative to juvenile chinook stranding, but will also serve as a base model for other ecological work in the Hanford Reach. In addition, a hydrosystems model will also likely be created by the affected hydroproject managers as a result of this study to coordinate operations among the seven hydroprojects located upstream of the Hanford Reach to allow special mitigation operations at the Priest Rapids project. The latter, is not a specific objective of this evaluation but is a likely indirect result currently being discussed by the Technical Work Group.

2) Complete final data analysis of all field data collected in 1997-99. This includes all data relative to the effects of diel water fluctuations on juvenile chinook, resident fish, and benthic macroinvertebrates. Most of this will be completed during FY99 (WDFW- juvenile chinook, USGS/BRD - chinook temperature tolerance, resident fish, Uof I - benthic macroinvertebrates) but some data analysis will continue during FY2000 in conjunction with objective 3.

3) Completion of the final report for all three years of work.

f. Methods

FY2000 work will consist largely of completion of ongoing data analysis begun in 1997 and will involve incorporation of data collected for all three years (Objective 2) and incorporating this information into a final report for the entire evaluation (Objective 3). Specific analysis has been detailed in previously reviewed and approved proposals for FY97-99. Expected results are:

1) determination of relationship between fall chinook size and susceptibility to stranding/entrapment.
2) determination of end of fall chinook susceptibilty time period to stranding/entrapment based upon fish size.
3)determination of relationship between fall chinook susceptibility to stranding/entrapment and incremental changes in water elevation.
4) determination of differences in fall chinook stranding susceptibility by habitat class.
5) direct and delayed mortality estimates for entrapped fall chinook (thermal stress and dessication).
6) identification of critical flow fluctuation bands.
Similar information will be derived for resident fish.
Completion of the modeling effort in FY2000 will consist largely of component data incorporation by PNNL into a Geographic Information System. The components will consist of: micro-habitat surveys of specific entrapment areas and fall chinook rearing areas by WDFW and USGS/BRD, Unsteady Flow Model developed by PNNL and used to describe the stage discharge relationship between the Priest Rapids project and the Hanford Reach, Instream Flow Incremental

Methodology Model describing flow and water velocity for Hanford Reach developed for BPA funded white sturgeon research by the USFWS, and Scanning Operational Airborne Lidar Survey (SHOALS) bathymetric data as collected by the US Army Corps of Engineers under subcontract for this project. SHOALS is a state of the art bathymetric survey technique involving a two part lazer system deployed from a helicopter with data relayed to a land based station. The bathymetric data is collected in 4X4 meter horizontal cells with approximately 10cm vertical resolution. The cost of this work will be shared between the Hanford Juvenile Fall Chinook Stranding Evaluation and a BPA funded USGS/BRD ongoing juvenile fall chinook habitat assessment also conducted in the Hanford Reach. Topographical benchmark surveys may be necessary during FY2000 in conjunction with the completion of the modeling effort to georeference the micro-habtitat work conducted in FY97-99. This and the SHOALS is the only field work anticipated for FY2000.

g. Facilities and equipment

No major equipment purchases are anticipated for FY2000. The modeling effort will be conducted at the PNNL Ecology Group complex and will utilize GIS related equipment at this location. As part of the modeling effort the USCOE will be subcontracted to conduct SHOALS work and all facilities and equipment necessary to conduct this work will be provided by the subcontractors. The USGS/BRD will complete the final phase of the resident fish assessment and the fall chinook temperature tolerance assessment at the Columbia River Research Laboratory during FY2000. The actual laboratory work will be completed under FY99 funds and funding for FY2000 will be simply for staff time as needed to complete data analysis and reporting. Similarly, WDFW staff will complete the final data analysis of juvenile chinook stranding susceptibility and will incorporate this information into a final report including chinook temperature tolerance (BRD), benthic macroinvertebrate assessment (to be completed in FY99 by the University of Idaho and Streamsides Program Consultation), resident fish assessment (WDFW and BRD), and modeling (PNNL and WDFW). WDFW staff activities will be centered at the Kennewick field office.

h. Budget

The total budget request for FY2000 is $217,000 to complete this evaluation. Approximately 1/2 of this is to be used to complete the susceptibility model including additional SHOALS work as needed to provide complete detailed bathymetry for the Hanford Reach. The cost of the SHOALS work will be split with another BPA funded project. The SHOALS work therefore should be considered as a multi-use product. The remainder of the FY2000 budget is essentially to cover staff time for final data analysis and integration of all data and data analysis including that from subcontracted research agencies for the three years of field work into a final report.

Section 9. Key personnel

Paul G. Wagner
Project Leader
1044 hours/0.5 FTE

Degrees Earned: B.S. Fisheries Management. University of Washington. Seattle.

1983.
Current Employer: Washington Department of Fish and Wildlife.

Employment History: Paul Wagner began employment with the Washington Department of Fish and Wildlife in 1983. He began work for WDFW under federal contracts in 1987 at McNary Dam as the Fish Transportation Oversight Team (FTOT) representative. He has extensive experience in juvenile fall chinook thermal mortality assessment at McNary Dam and initiated the thermal profiling procedure currently in effect at that project. In 1990 he became the McNary Smolt Monitoring Program supervisor and began conducting independent and cooperative research projects under federal contracts that same year. Most noteworthy research included the 1990 and 1991 evaluations of adult fallback at McNary Dam. In 1992, he initiated the first PIT tagging project for wild upriver bright fall chinook on the Hanford Reach which was later incorporated into the Smolt Monitoring Program. He has been a member of the Vernita Bar Monitoring Team for determination of critical flows for the protection of pre-emergent fall chinook in the Hanford Reach since 1987. Currently under federal contracts, he acts as the WDFW project leader in juvenile passage related research in the Columbia basin. He also supervises Smolt Monitoring Program, Gas Bubble Trauma Monitoring, and Transportation/Bypass System Quality Control at McNary, Ice Harbor, and Lower Monumental Dams. Hanford Reach Juvenile Fall Chinook Stranding Evaluation project leader from 1997 through the present.

Publications:

Wagner, P. 1990 McNary Dam Smolt Monitoring Program. Annual Report. State of Washington. Department of Fisheries. Habitat Management Division. Prepared for United States Department of Energy. Bonneville Power Administration. Division of Fish and Wildlife. Project Number 87-127. Contract Number DE-FC79-88BP38906. 20 pages.

Wagner, P. 1990 Evaluation of The Use of The McNary Bypass System To Divert Adult Fallbacks Away From Turbine Intakes. State of Washington. Department of Fisheries. Habitat Management Division. Report to United States Army Corps of Engineers. Modification to Contract Number DACW-68-82-C-0077. Task Order Number 9. 72 pages.

Wagner, P. 1991 McNary Dam Smolt Monitoring Program. Annual Report. State of Washington. Department of Fisheries. Habitat Management Division. Prepared for United States Department of Energy. Bonneville Power Administration. Division of Fish and Wildlife. Project Number 87-127. Contract Number DE-FC79-88BP38906. 40 pages.

Wagner P., and T. Hillson. 1991 Evaluation of Adult Fallback Through The McNary Dam Juvenile Bypass System. State of Washington. Department of Fisheries. Habitat Management Division. Report to United States Army Corps of Engineers. Contract Number DACW-68-82-C-0077. Task Order Number 10. 79 pages.

Nelson W., D. Rondorf, and P. Wagner. Subyearling Chinook Salmon Marking at McNary Dam to Estimate Adult Contribution. 1992. United States Fish and Wildlife Service. Columbia River Research Laboratory. Washington Department of Fisheries. Habitat Management Division.

Annual Report to The Bonneville Power Administration. 13 pages.

Relationship to Project: Paul Wagner is the project leader of this evaluation and has acted in this capacity since the project began in 1997. He is responsible for overall development of study design and budget management, study implementation, oversight of subcontracted parties, analysis of data, supervision of WDFW staff, interim and final report writing, and coordination with collaborating agencies and affected parties.

David R. Geist
Senior Research Scientist
150 hours/0.07FTE

EDUCATION

B.S., Biology, Eastern Washington University, 1984
M.S.,Biology, Eastern Washington University, 1987
Ph.D., Oregon State University, 1998

Employer and Experience

Mr. Geist is a Senior Research Scientist in the Ecology Group at Battelle, Pacific Northwest National Laboratory. He has been with Battelle since 1991 and has extensive experience and expertise in the ecology of Pacific Northwest fishes, especially fall chinook salmon in the Hanford Reach. His research involves developing and testing a conceptual spawning habitat model that describes the importance of landscape processes in determining utilization of spawning areas by fall chinook salmon. Mr. Geist has served on several technical panels related to future management of the Hanford Reach, including invited expert testimony at Congressional hearings. He is a member of the American Fisheries Society and American Institute of Fishery Research Biologists. Recent research activities include:

- Lead scientist and project manager for several projects addressing environmental monitoring and technology applications, including investigating habitat utilization, bioenergetics, and migration behavior of fall chinook salmon in the Columbia River.
- Studying ground-water/surface-water interactions and contaminant movement in salmon spawning areas in the Hanford Reach.
- Modeling impacts of hydropower system operations on resident fish in the Upper Columbia River, including Lake Roosevelt; and participating in planning and evaluation activities of salmon supplementation in the Yakima and Klickitat rivers.

SELECTED PUBLICATIONS

Geist, D.R. 1995. "The Hanford Reach: What Do We Stand to Lose?" Illahee 11:130-141

Geist, D.R., M.C.Joy, D.R. Lee, and T. Gonser. In press. "A Method for Installing Piezometers in Large Cobble Bed Rivers". Ground Water Monitoring and Remediation.

Geist, D.R., and D.D. Dauble. In press. "Redd Site Selection and Spawning Habitat Use by Fall Chinook Salmon: the Importance of Geomorphic Features in Large Rivers." Environmental Management.

Geist, D.R., D.D. Dauble, and R.H. Visser. 1997. "The development of a spawning habitat model to aid in recovery plans for Snake River chinook salmon." Fiscal Year 1995 and 1996 Progress Report to the Bonneville Power Administration, Portland, Oregon.

Geist, D.R., L.W. Vail, and D.J. Epstein. 1996. "Analysis of potential Impacts to Resident Fish from Columbia River System Operation Alternatives". Environmental Management 20:275-288

Relationship to Project: Mr. Geist will serve as Project Manager for the portion of the modeling effort to be conducted under subcontract in conjunction with WDFW staff. His primary responsibilities will be to ensure that project milestones are met on time and within budget and to coordinate assimilation of model components.

John J. Nugent
Fish Biologist/GIS Specialist
1500 hours/0.75FTE

Current Employer: Pacific States Marine Fisheries Commission
Supervised by Washington Department of Fish and Wildlife

Degrees Earned: B.S., Geology, University of Georgia, Athens, 1985
B.S., Wildlife Biology, University of Montana, Missoula, 1994
M.S., Environmental Studies, University of Montana, Missoula, 1995

Previous Employers: 1991 to Present Battelle, Pacific Northwest National Laboratory
1997 to Present Pacific States Marine Fisheries Commission

Expertise: Worked on a variety of ecological research and monitoring projects in southeastern Washington primarily on the U.S. Department of Energy's Hanford Site and the U.S. Army's Yakima Training Center. Several projects involved the use of Geographic Information Systems to model habitat use by species of concern (ferruginous, Swainson's, red-tailed hawks, sage grouse, sage sparrows), determine impacts of human activities (military training exercises, environmental cleanup activities), and identify areas for mitigation and restoration (sagebrush restoration). Other projects included wildlife surveys (nesting raptors, bald eagles, deer and elk) and vegetation mapping. Also provided technical support on the development of a biological resource management plan, underwater video surveys of fall chinook salmon spawning sites on lower Snake River, and characterization of water velocities at fall chinook salmon spawning sites using an Acoustic Doppler Current Profiler. Some projects required the use of remotely sensed data, Global Positioning Systems, trapping and handling of animals, and radiotelemetry.

Publications:

Nugent, J. J. 1995. Nest-site and habitat selection of Buteo species in southeastern Washington and the use of geographic information systems to model nest habitat. M.S. thesis, University of Montana, Missoula, Montana.

Bromenshenk, J. J., R. C. Cronn, and J. J. Nugent. 1996. Monitoring fluoride with honey bees in the upper Snake River Plain of Idaho. J. Environ. Qual. 25:868-877.

Cadwell, L. L., M. A. Simmons, J. J. Nugent, and V. I. Cullinan. 1996. Sage grouse habitat on the Yakima Training Center: part II habitat modeling (draft). Pacific Northwest National Laboratory, Richland, Washington.

Watson, V., J. Rokosch, J. J. Nugent, S. Manley, and J. Moore. 1993. Copper and zinc in aquatic insects in the upper Clark Fork River. Proc. Mont. Acad. Sci. 53:25-32.

Downs, J. L., W. H. Rickard, C. A. Brandt, L. L. Cadwell, C. E. Cushing, D. R. Geist, R. M. Mazaika, D. A. Neitzel, L. E. Rogers, M. R. Sackschewsky, and J. J. Nugent. 1993. Habitat types on the Hanford Site: wildlife and plant species of concern. PNNL-8942, Pacific Northwest Laboratory, Richland, Washington.

Relationship to Project: John Nugent has conducted Geographic Information System work for the Pacific Northwest National Laboratories since 1991. He was hired through the Pacific States Marine Fisheries Commission as a shared employee for the Hanford Stranding Evaluation (Project # 9701400) and the PNNL spawning habitat model for Snake River fall chinook project (Project #9406900) in 1997-98. John maintains his office in the PNNL complex and serves as the technical GIS lead for the Hanford Stranding Evaluation and is responsible for a large portion of the final data analysis and reporting.

Marshall C. Richmond
Senior Research Engineer, Hydrology Group, Environmental Technology Division
Battelle, Pacific Northwest Laboratories
150 hours/0.07FTE

Current Employer: Battelle, Pacific Northwest National Laboratories

Degrees Earned: Ph.D., Civil and Environmental Engineering
University of Iowa, 1987

M.S., Civil and Environmental Engineering
Washington State University, 1983

B.S., Civil and Environmental Engineering
Washington State University, 1982

Professional Registration: Engineer-In-Training, No. 10729, Washington, July 1982

Expertise: Dr. Richmond rejoined Battelle Pacific Northwest Laboratories in 1994 as a Senior Research Engineer in the Hydrology Group. His professional experience includes basic and applied research, university teaching, and project management. His principal areas of expertise are in the development and application of computational models of contaminant transport and fate in environmental systems, physical modeling of hydraulic structures, fisheries engineering, sediment transport modeling, and turbulence modeling in computational fluid dynamics.
Projects:

Unsteady Flow and Dissolved Gas Transport Modeling Surface Runoff and Contaminant Transport in Watersheds Hydraulic and Contaminant Transport Modeling of Rivers.

Publications:

Walters, W.H., M.C. Richmond, and B.A. Gilmore. 1996. Restruction of Radioactive Contamination in the Columbia River. Health Physics, bol. 71, No. 4, pp. 556-567.

Paluszkiewicz, T., L.F. Hibler, M.C. Richmond, D.J. Bradley, and S.A. Thomas. 1996. Modeling the Potential Radionuclide Transport by the Ob and Yenisey Rivers to the Kara Sea. Accepted for publication in Marine Pollution Bulletin.

Richmond, M.C. 1995. Strategies for Modeling Dissolved Gas Transport in the Columbia and Snake Rivers. U.S. Army Corps of Engineers Gas Abatement Study Modeling Workshop, Newport, OR, February 1-2, 1995.

Richmond, M.C., M.S. Wigmosta, and W.A. Perkins. 1998. Lower Snake River Hydraulics and Sediment Transport, Pacific Northwest National Laboratory, Richland, Washington.

Walters, W.H., M.C. Richmond, and B.G. Gilmore. 1993. Reconstruction of Radionuclide Concentrations in the Columbia River from Hanford, Washington to Portland, Oregon for January 1950-January 1971. Hanford Environmental Dose Reconstruction Project. PNWD-2225 HEDR. Battelle Pacific Northwest Laboratories, Richland, Washington.

Relationship to Project: Marshall Richmond is the senior research engineer with PNNL and is a technical expert in the area of flow dynamics and river system modeling. He was the technical lead in the development of the unsteady flow model used for modeling total dissolve gas movement on the Snake River (under COE contract) and the unsteady flow model describing Columbia River flow dynamics for the Hanford Reach used in the Hanford Stranding Evaluation (Project # 9701400).

Name: Matthew G. Mesa
Title: Research Fishery Biologist
175 hours/0.08FTE

Degrees Earned: Advancement to candidacy for Ph.D.
Oregon State University, 1995

M.S., Fisheries
Oregon State University, 1989

B.S., Natural Resource Management
California Polytechnic State University, 1984
at San Luis Obispo

Current Employer: U.S. Geological Survey, Biological Resources Division
Columbia River Research Lab, Cook, WA

Previous Employers: 1991-Present Research Fishery Biologist, U.S. Geological Survey, Biological Resources Division, Columbia River Research Lab, Cook, WA

1989-1991 Fishery Biologist, U.S. Fish and Wildlife Service, Seattle-NFRC, Columbia River Field Station, Cook, WA

1986-1989 Fishery Biologist/CEA Appointee, Seattle-NFRC, Oregon Cooperative Fisheries Research Unit, Oregon State University, Corvallis, OR

1984-1986 Fishery Biologist, U.S. Fish and Wildlife Service, Seattle-NFRC, Columbia River Field Station, Cook, WA

Expertise: Team leader on research projects addressing the effects of dissolved gas supersaturation on juvenile salmonids and evaluating predator-prey relations in Columbia River fishes. Areas of expertise include predator-prey interactions in fishes, fish behavior and performance, and general and stress physiology of fishes.

Publications:

Mesa, M.G. and C.B. Schreck. 1989. Electro fishing mark-recapture and depletion methodologies evoke behavioral and physiological changes in cutthroat trout. Transactions of the American Fisheries Society 118:644-658.

Mesa, M.G. 1991. Variation in feeding, aggression, and position choice between hatchery and wild cutthroat trout in an artificial stream. Transactions of the American Fisheries Society 120:723-727.

Mesa, M.G. 1994. Effects of multiple acute stressors on the predator avoidance ability and physiology of juvenile chinook salmon. Transactions of the American fisheries Society 123:786-793.

Mesa, M.G., T.P. Poe, D.M. Gadomski, and J.H. Petersen. 1994. Are all prey created equal? A review and synthesis of differential predation on prey in substandard condition. Journal of Fish Biology 45 (Supplement A):81-96.

Mesa, M.G., T.P. Poe, A.G. Maule, and C.B. Schreck. In press. Vulnerability to predation and physiological stress responses in juvenile chinook salmon experimentally infected with Renibacterium salmoninarum. Canadian Journal of Fisheries and Aquatic Sciences.

Relationship to Project: Matt Mesa will act as the project leader evaluating thermal tolerance of juvenile fall chinook in relationship to entrapment and exposure to warm water on the Hanford Reach. He is responsible for literature review, budget and work plan development including laboratory physiological and behavioral testing methodology, analysis of data, and reporting. He is responsible for overall supervision of thermal tolerance tests conducted at the USGS/BRD Columbia River Research Laboratory as related to the Hanford Stranding Evaluation.

Dena M. Gadomski
Research Biologist
350 hours/0.16FTE
U.S. Geological Survey - Biological Resources Division
Columbia River Research Laboratory
5501A Cook-Underwood Road
Cook, Washington 98605

Education:

Oregon State University, College of Oceanography	M.S. Biological Oceanography	1983
University of California, Berkeley	B.A. Biology	1976

Current Employment: Research Fishery Biologist. U.S. Geological Survey, Biological Resources Division, Columbia River Research Laboratory, Cook, WA, 1990-present. Currently, Dena is a team leader for a project studying possible effects of lower Snake River drawdown on predation-related juvenile salmonid mortality which includes early life history assessment of resident predatory fish in the Hells Canyon area of the Snake River and the Hanford Reach of the Columbia River. The focus of this research is to understand the basic early life history of the northern pikeminnow Ptychocheilus oregonensis, a dominant predator of juvenile salmonids. She is also involved in research examining the abundance and distribution of larval and juvenile fishes in the Columbia River Basin.

Recent Previous Employment: Project Manager/Fisheries Scientist. Occidental College, VANTUNA Research Group, Los Angeles, CA, 1985-1989.

Expertise: Larval and juvenile fish ecology including larval resident fish identification. Predator-prey interactions.

Recent Relevant Publications:

Barfoot, C.A., D.M. Gadomski, and R.H. Wertheimer. 1998. Growth and mortality of age-0 northern squawfish, Ptychocheilus oregonensis, rearing in shoreline habitats of a Columbia River Reservoir. Environmental Biology of Fishes. In press.

Gadomski, D.M., and C.A. Barfoot. 1998. Diel and distributional abundance patterns of fish embryos and larvae in the lower Columbia and Deschutes rivers. Environmental Biology of Fishes. 51: 353-368.

Gadomski, D.M., and S.M. Caddell. 1996. Effects of temperature on the development and survival of eggs of four coastal California fishes. Fishery Bulletin, U.S. 94: 41-48

Gadomski, D.M., M.G. Mesa, and T.M. Olson. 1994. Vulnerability to predation and physiological stress responses of experimentally descaled juvenile chinook salmon, Oncorhynchus tshawytscha. Environmental Biology of Fishes. 39: 191-199.

Relationship to Project: Dena Gadomski currently conducts larval resident fish identification at the Columbia River Research Laboratory for the Hanford Stranding Evaluation as part of a cooperative effort between this evaluation and a COE funded predatory fish evaluation also being conducted in the Hanford Reach. She, in conjunction with WDFW staff, will act as the technical lead in the final evaluation and reporting of the effect of diel water fluctuations on resident fish in the Hanford Reach.

Dennis W. Rondorf
Fishery Research Biologist
0 hours/0 FTE

Degrees Earned: M.S. Oceanography and Limnology, University of Wisconsin, Madison, 1981
B.S. Wildlife Management, University of Minnesota, St. Paul, 1972

Current Employment and Responsibilities: D.W. Rondorf serves as a Fishery Research Biologist and Section Leader for the Anadromous Fish Ecology section at the Columbia River Research Laboratory, Biological Resources Division, U.S. Geological Survey, Cook, Washington. Current areas of research include the behavior and ecology of Snake River wild and hatchery fall chinook salmon, the distribution of smolts and relation to gas supersaturation in the main stem Columbia River, and behavior of smolts to evaluate a prototype surface collector at Lower Granite Dam, Washington. In recent years, D.W. Rondorf has lead research teams using radio telemetry, geographic information systems (GIS), global positioning systems (GPS), remotely operated underwater vehicles (ROV), hydro acoustic fish stock assessment systems, and acoustic Doppler current profilers (ADCP) as research tools. Between 1979 and 1997, D.W. Rondorf was employed by the research division of the U.S. Fish and Wildlife Service and the National Biological Service to conduct research on juvenile salmon in the Columbia River basin including identification of spawning, rearing, and migratory requirements of fall chinook salmon in the Columbia River Basin with much of the work conducted in the Hanford Reach.

Publications:

Rondorf, D.W. and K.F. Tiffan, editors. Identification of the spawning, rearing, and migratory requirements of fall chinook salmon in the Columbia River Basin. 1992 Annual Report to Bonneville Power Administration. Contract DE-A179-91BP21708, Portland, Oregon.

Rondorf, D.W. and K.F. Tiffan, editors. Identification of the spawning, rearing, and migratory requirements of fall chinook salmon in the Columbia River Basin. 1993 Annual Report to Bonneville Power Administration. Contract DE-A179-91BP21708, Portland, Oregon.

Rondorf, D.W. and K.F. Tiffan, editors. Identification of the spawning, rearing, and migratory requirements of fall chinook salmon in the Columbia River Basin. 1994 Annual Report to Bonneville Power Administration. Contract DE-A179-91BP21708, Portland, Oregon.

Rondorf, D.W. and K.F. Tiffan, editors. Identification of the spawning, rearing, and migratory requirements of fall chinook salmon in the Columbia River Basin. 1995 Annual Report to Bonneville Power Administration. Contract DE-A179-91BP21708, Portland, Oregon.

Parsley, M.J., D.W. Rondorf, and M.E. Hanks. 1998. Remote sensing of fish and their habitats. Proceedings of instream and environmental flows symposium-technology and policy issues. (In Press) North American Lake Management Society and others, Denver, Colorado.

Relationship to Project: Dennis Rondorf has been the project leader for USGS/BRD juvenile fall chinook habitat utilization assessment in the Hanford Reach since 1991. This work includes juvenile chinook micro-habitat map surveying which is a necessary component of the susceptibility model being developed for the Hanford Stranding Evaluation. WDFW and USGS/BRD are working in collaboration through sharing of staff and equipment to collect this survey information. The collected data will be used by both studies. In addition, cost sharing between USGS/BRD and WDFW will occur to conduct a Scanning Hydrographic Operational Airborne Lidar Survey (SHOALS) of the Hanford Reach to obtain detailed bathymetric data. Mr. Rondorf serves as the technical lead for this work. The bathymetric data is again a necessary component of the susceptibility model and the collected data will be shared between the two BPA funded projects (9102900 and 9701400). Mr. Rondorf is listed as a cooperating participant under the Hanford Stranding Evaluation but funding for his work relative to this evaluation will be covered under another project (9102900).

Section 10. Information/technology transfer

Specific data derived from this work will be exchanged among all collaborating agencies and available upon request to other groups. A completion report will be distributed upon request. Internet access to the Unsteady Flow and Susceptibility models will be made available.

Congratulations!